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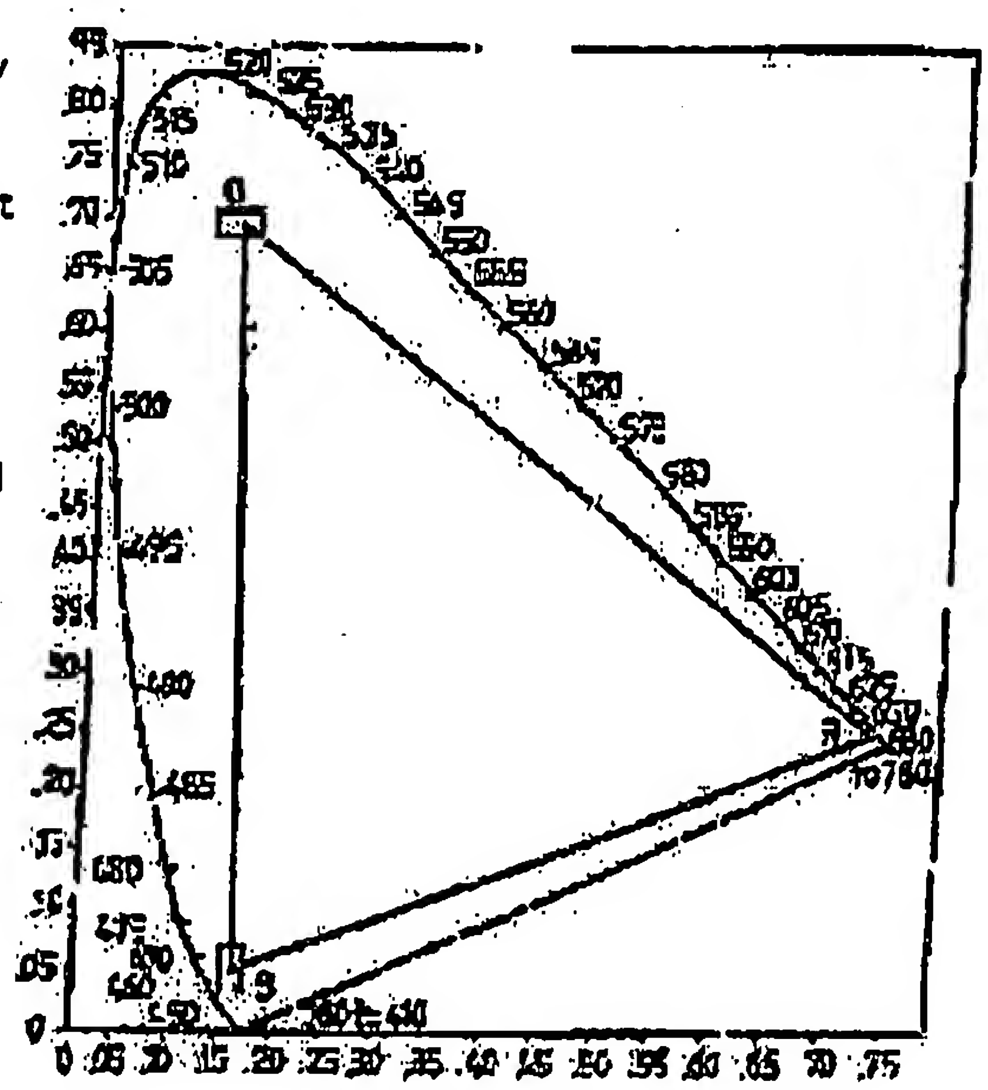
(54) METHOD FOR COMPENSATING NONUNIFORMITY OF DISPLAY BY CHANGE IN PRIMARY COLOR OF COLOR MONITOR

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a method for compensating the nonuniformity of display by a change in primary colors of a color monitor by using a virtual primary color method.
SOLUTION: The chromaticity coordinates and maximum luminance of the primary colors of respective pixels in the monitor are measured and one set of virtual primary colors are selected from the measured values of all the primary colors. The tristimulus values of the respective virtual primary colors are generated from the respective pixels in the monitor. The characteristics of the virtual primary colors are displayed by the chromaticity coordinates and the maximum luminance and may be substituted for the virtual primary colors selected of the primary colors and therefore all the pixels have the same virtual primary colors and the color display of the monitor is made uniform. When the differences between the primary colors and the tristimulus values of the virtual primary colors are small, the relations between input video signals and light source modulation signals are searched in order to make the tristimulus values of the primary colors in the pixels and the tristimulus values of the virtual primary colors identical or analogous. The tristimulus values of the primary colors and the tristimulus values of the virtual primary colors are so set as to coincide or resemble. Further, conversion coefficients are calculated and the input video signals are changed to the light source modulation signals and the drive signals of the primary colors in the monitor are generated by the light source modulation signals.



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1.This document has been translated by computer. So the translation may not reflect the original precisely.
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CLAIMS

[Claim(s)]

[Claim 1] While the chromaticity coordinate and the maximum brightness of primary color of each pixel in a monitor are measured and the maximum brightness is brightness generated when not the brightness generated according to the light source of primary color but a fixed current or an electrical potential difference is built in case luminescence of primary color is modulated by pulse width, brightness is average brightness in a time slot. The virtual primary color of a lot is chosen from the measured value of all primary colors, and the tristimulus values of each virtual primary color occur from each pixel in a monitor. The property of the virtual primary color Since it can permute by the virtual primary color which had primary color chosen while being displayed by a chromaticity coordinate and the maximum brightness Since the color display of a monitor becomes homogeneity, and homogeneity is accepted in the color display in a monitor when the difference of the tristimulus values of primary color and virtual primary color is small while having virtual primary color with all the same pixels. The tristimulus values of primary color and the tristimulus values of virtual primary color in a pixel the same or in order to make it similar You may set up so that it may be similar, or it looks for the relation between an input video signal and a light source modulating signal and the tristimulus values of primary color and the tristimulus values of virtual primary color are in agreement. Furthermore, the method of compensating non-** - of the display by change of the primary color of a color monitor which calculates a conversion coefficient, changes an input video signal into a light source modulating signal, and is characterized by generating the driving signal of the primary color in a monitor with a light source modulating signal.

[Claim 2] The approach of choosing three primary colors or the virtual primary color in the monitor of the primary color beyond it In order to make the chromaticity coordinate of each virtual primary color with the combination by all the primary colors in each pixel In order to choose the virtual primary color of a lot and to just make the value of a light source modulating signal eternal How to compensate the ununiformity of the display by change of the primary color of a color monitor according to claim 1 which makes the maximum brightness of each virtual primary color lower than the maximum brightness of corresponding primary color, and is characterized by adjusting proportionally between the maximum brightness of virtual primary color by the white balance.

[Claim 3] The approach of choosing the virtual primary color of a monitor in three primary colors is [Equation 1].

$$X_{vr}^{m}=Min\{X_{or}^{m}(j)\},$$

$$Y_{vr}^{m}=Max\{Y_{or}^{m}(j)\},$$

$$Z_{vr}^{m}=Max\{Z_{or}^{m}(j)\},$$

It is the maximum in the tristimulus values of the virtual primary color of red [in / the maximum in the tristimulus values of red virtual primary color is chosen by the ** type, and / in Xmor (j), Ymor (j), and Zmor (j) in it / the pixel of the j-th piece of a monitor], and Min {V (j)} is the minimum value V to all j, and is Maximum V to all j, and Max {V (j)} is [Equation 2].

$$X_{vg}^{m}=Max\{X_{og}^{m}(j)\},$$

$$Y_{vg}^{m}=Min\{Y_{og}^{m}(j)\},$$

$$Z_{vg}^{m}=Max\{Z_{og}^{m}(j)\},$$

It is the maximum in the tristimulus values of the virtual primary color [in / the maximum in the tristimulus values of the virtual primary color which can be set green by the ** type is chosen, and / in Xmog (j), Ymog (j), and Zmog (j) in it / the pixel of the j-th piece of a monitor] which can be set green, and is [Equation 3].

$$X_{vb}^{m}=Max\{X_{ob}^{m}(j)\},$$

$$Y_{vb}^{m}=Max\{Y_{ob}^{m}(j)\},$$

$$Z_{vb}^{m}=Min\{Z_{ob}^{m}(j)\},$$

The maximum in the tristimulus values of the virtual primary color which can be set blue by the ** type is chosen. Xmob (j), Ymob (j), and Zmob (j) in it are the maximum in the tristimulus values of the blue virtual primary color in the pixel of the j-th piece of a monitor. The chromaticity coordinate and the maximum brightness in red and green and blue virtual primary color are calculated from the maximum of the tristimulus values of the red chosen by the above-mentioned approach, and the virtual primary color which can be set green and blue. By the white balance How to compensate the ununiformity of the display by change of the primary color of a color monitor according to claim 1 characterized by adjusting proportionally between the maximum brightness of virtual primary color.

[Claim 4] The relation of the input video signal and light source modulating signal in a monitor in three primary colors is [Equation 4].

$$\sum_{\alpha=r,g,b} X'_{0\alpha}(n,j)=\sum_{\alpha=r,g,b} X_{v\alpha}(n,j)$$
$$\sum_{\alpha=r,g,b} Y'_{0\alpha}(n,j)=\sum_{\alpha=r,g,b} Y_{v\alpha}(n,j)$$
$$\sum_{\alpha=r,g,b} Z'_{0\alpha}(n,j)=\sum_{\alpha=r,g,b} Z_{v\alpha}(n,j)$$

It asks by the ** type and Xtoalpha (n, j), Ytoalpha (n, j), and Ztoalpha (n, j) in it are all the tristimulus values of alpha color primary color in the pixel of the j-th piece of n drawings. alpha shows red, green, or blue and Xvalpha (n, j), Yvalpha (n, j), and Zvalpha (n, j) are all the tristimulus values of alpha color virtual primary color in the pixel of the j-th piece of n drawings. alpha shows red, green, or blue, the sum of tristimulus values adds red and green and blue tristimulus values, and it is [Equation 5] about each above-mentioned formula, respectively.

$$a_\alpha(n,j)=\sum_\beta c_{\alpha\beta}(j)s_\beta(n,j), \quad (\alpha,\ \beta=\ r,\ g,\ b)$$

ar which is the light source modulating signal of the red in the pixel of the j-th piece of n drawings, and green and blue primary color when it puts into a ** type (n, j), ag (n, j) and ab (n, j) are obtained. These Sr (n, j), Red [in / in Sg (n, j) and respectively Sb (n, j) / the pixel of the j-th piece of n drawings of a monitor], It is the approach of being the input video signal of green and blue primary color, and compensating the ununiformity of the display by change of the primary color of a color monitor according to claim 1 characterized by C**** (j) being a conversion coefficient about the pixel of the j-th piece of a monitor.

[Claim 5] The relation of the input video signal and light source modulating signal in the monitor more than three primary colors is [Equation 6],

$$\sum_\alpha X'_{0\alpha}(n,j)=\sum_\alpha X_{v\alpha}(n,j)$$
$$\sum_\alpha Y'_{0\alpha}(n,j)=\sum_\alpha Y_{v\alpha}(n,j)$$
$$\sum_\alpha Z'_{0\alpha}(n,j)=\sum_\alpha Z_{v\alpha}(n,j)$$

The Ruhr of a ** type and color separation asks. The usual input video signal in it Since there is only a signal of red and three green and blue colors, by the Ruhr of the color separation It is necessary to separate the specific gravity or video signal of each primary color. Xtoalpha (n, j), Ytoalpha (n, j) and Ztoalpha (n, j) are all the tristimulus values of alpha color primary color in the pixel of the j-th piece of n drawings of a monitor. alpha in it shows one in red, green, and blue. Xvalpha (n, j), It is all the tristimulus values of alpha color virtual primary color in the pixel of the j-th piece of n drawings. alpha in it is one in tristimulus values, the sum of the tristimulus values of said formula adds the tristimulus values of all primary colors, and Yvalpha (n, j) and Zvalpha (n, j) are [Equation 7] about each above-mentioned formula, respectively.

$$a_\alpha(n,j)=\sum_\beta c^m_{\alpha\beta}(j)s^m_\beta(n,j)$$

When it puts into a ** type, aalpha (n, j) is called for and Smbeta (n, j) is the video signal of beta color primary color in the pixel of the j-th piece of n drawings of a monitor. When converting the red in it, and a green and blue input video signal, Smbeta (n, j) is an input video signal. When beta expresses red, green, or blue and the video signal of three or more colors is converted, Smbeta (n, j) is a video signal corresponding to each primary color already separated by red and the green or blue input video signal. beta is the approach of being one of them and compensating the ununiformity of the display by change of the primary color of a color monitor according to claim 1 characterized by Cm**** (j) being a thing about the conversion coefficient in the pixel of the j-th piece of a monitor.

[Claim 6] The step which calculates a conversion coefficient is the approach of compensating the ununiformity of the display by change of the primary color of a color monitor according to claim 1 characterized by substituting for the formula of the conversion coefficient which obtained the chromaticity coordinate of each primary color of each pixel in a monitor, and the measured value of the maximum brightness at the step which looks for the relation between an input video signal and a light source modulating signal.

[Claim 7] How to compensate the ununiformity of the display by change of the primary color of a color monitor according to claim 1 characterized by having the step which memorizes a conversion coefficient, the step which accepts a video signal in a control unit, the step which downloads the conversion coefficient memorized by memory to an arithmetic and logic unit, the step calculated by the arithmetic and logic unit, and the step which converts a video signal into a light source modulating signal in the system which converts a video signal into a light source modulating signal.

[Claim 8] While the light source modulating signal acquired in the step which converts a video signal is used for the step which generates a light source driving signal and modulating the driving signal of primary color When it has relation with the nonlinear the brightness and the amount of modulations of a driving signal of the primary color in it, Before modulating a light source modulating signal to the driving signal of primary color, this nonlinear relation is corrected and a light source modulating signal is amended. The amount of modulations of a driving signal For example, it is the approach of compensating the ununiformity of the display by change of the primary color of a color monitor according to claim 1 which the magnitude of the starting current is expressed in the case of amplitude modulation, and is characterized by expressing the pulse width of the starting current in the case of pulse width modulation.

[Claim 9] While the chromaticity coordinate and the maximum brightness of primary color of each pixel in a monitor are measured and the maximum brightness is brightness generated when not the brightness generated according to the light source of primary

color but a fixed current or an electrical potential difference is built in case luminescence of primary color is modulated by pulse width, brightness is average brightness in a time slot. The virtual primary color of a lot is chosen from all the measured value of the primary color used for a monitor. It generates from the primary color in which all the combination of each pixel [in / in the tristimulus values of each virtual primary color / a monitor] is possible. The property of the virtual primary color Since it can permute by the virtual primary color which had primary color chosen while being displayed by a chromaticity coordinate and the maximum brightness While having virtual primary color with all the same pixels, the color display of a monitor becomes homogeneity. Since the chromaticity coordinate and the maximum brightness of primary color in each pixel in a monitor are measured, and homogeneity is accepted in the color display in a monitor when the difference of the tristimulus values of primary color and virtual primary color is small after primary color is prepared in a monitor, The tristimulus values of primary color and the tristimulus values of virtual primary color in a pixel the same or in order to make it similar You may set up so that it may be similar, or it looks for the relation between an input video signal and a light source modulating signal and the tristimulus values of primary color and the tristimulus values of virtual primary color are in agreement. Furthermore, the method of compensating the ununiformity of the display by change of the primary color of a color monitor which calculates a conversion coefficient, changes an input video signal into a light source modulating signal, and is characterized by generating the driving signal of the primary color in a monitor with a light source modulating signal.

[Claim 10] The approach of choosing three primary colors or the virtual primary color in the monitor of the primary color beyond it in order to make the chromaticity coordinate of each virtual primary color with the combination by all the primary colors in each pixel in order to choose the virtual primary color of a lot and to just make the value of a light source modulating signal eternal How to compensate the ununiformity of the display by change of the primary color of a color monitor according to claim 9 which makes the maximum brightness of each virtual primary color lower than the maximum brightness of corresponding primary color, and is characterized by adjusting proportionally between the maximum brightness of virtual primary color by the white balance.

[Claim 11] The maximum of the tristimulus values of the red virtual primary color chosen in the approach of choosing the virtual primary color of a monitor in three primary colors when the primary lights of the red of Nr individual were contained in one pixel is [Equation 8].

$$X_{vr}^{m} = N_r \times Min\{X_{or}^{m}(j)\}$$

$$Y_{vr}^{m} = N_r \times Max\{Y_{or}^{m}(j)\}$$

$$Z_{vr}^{m} = N_r \times Max\{Z_{or}^{m}(j)\}$$

It asks by the ** type and Xmor (j), Ymor (j), and Zmor (j) in it are the maximum of the tristimulus values of the red primary color used for the monitor of the j-th piece. For Max {V (j)}, the maximum of the tristimulus values of the green virtual primary color chosen when it was the minimum value V to all j, and it was Maximum V and the primary lights of the red of Ng individual were contained in one pixel to all j is [Min {V (j)}] [Equation 9].

$$X_{vg}^{m} = N_g \times Max\{X_{og}^{m}(j)\}$$

$$Y_{vg}^{m} = N_g \times Min\{Y_{og}^{m}(j)\}$$

$$Z_{vg}^{m} = N_g \times Max\{Z_{og}^{m}(j)\}$$

The maximum of the tristimulus values of the blue virtual primary color which was called for by the ** type, Xmog (j), Ymog (j), and Zmog (j) in it were the maximum of the tristimulus values of the green primary color used for the monitor of the j-th piece, and was chosen when the primary lights of the red of Nb individual were contained in one pixel is [Equation 10].

$$X_{vb}^{m} = N_b \times Max\{X_{ob}^{m}(j)\}$$

$$Y_{vb}^{m} = N_b \times Max\{Y_{ob}^{m}(j)\}$$

$$Z_{vb}^{m} = N_b \times Min\{Z_{ob}^{m}(j)\}$$

It asks by the ** type and Xmob (j), Ymob (j), and Zmob (j) in it are the maximum of the tristimulus values of the blue primary color used for the monitor of the j-th piece. The chromaticity coordinate and the maximum brightness in red and green and blue virtual primary color are calculated from the maximum of the tristimulus values of the red chosen by the above-mentioned approach, and the virtual primary color which can be set green and blue. According to the conditions of a white balance How to compensate the ununiformity of the display by change of the primary color of a color monitor according to claim 9 characterized by adjusting proportionally between the maximum brightness of virtual primary color.

[Claim 12] The relation of the input video signal and light source modulating signal in a monitor in three primary colors is [Equation 11].

$$\sum_{\alpha=r,g,b} X_{0\alpha}^{\prime}(n,j) = \sum_{\alpha=r,g,b} X_{v\alpha}(n,j)$$

$$\sum_{\alpha=r,g,b} Y_{0\alpha}^{\prime}(n,j) = \sum_{\alpha=r,g,b} Y_{v\alpha}(n,j)$$

$$\sum_{\alpha=r,g,b} Z_{0\alpha}^{\prime}(n,j) = \sum_{\alpha=r,g,b} Z_{v\alpha}(n,j)$$

It asks by the ** type and Xtoalpha (n, j), and Ytoalpha (n, j) and Ztoalpha (n, j) in it are all the tristimulus values of alpha color primary color in the pixel of the j-th piece of n drawings. alpha in it shows one in red, green, or blue. Xvalpha (n, j). It is the tristimulus values of alpha color virtual primary color in the pixel of the j-th piece of n drawings, and alpha in it shows one in red, green, or blue, the sum of the tristimulus values of said formula adds tristimulus values in three primary colors, and Yvalpha (n, j) and Zvalpha (n, j) are [Equation 12] about each above-mentioned formula, respectively.

$$a_\alpha(n,j)=\sum_\beta c_{\alpha\beta}(j)s_\beta(n,j), \qquad (\alpha,\ \beta=r,\ g,\ b)$$

If it puts into a ** type, Sr (n, j), Sg (n, j), and Sb (n, j) will be calculated. Red [in / in respectively the Sr (n, j), Sg (n, j), and Sb (n, j) / the pixel of the j-th piece of n drawings of a monitor], It is the approach of being a green and blue input video signal, and compensating the ununiformity of the display by change of the primary color of a color monitor according to claim 9 characterized by C**** (j) being a thing about the conversion coefficient in the pixel of the j-th piece of a monitor.

[Claim 13] The relation of the input video signal and light source modulating signal in the monitor more than three primary colors is [Equation 13].

$$\sum_\alpha X'_{0\alpha}(n,j)=\sum_\alpha X_{v\alpha}(n,j)$$
$$\sum_\alpha Y'_{0\alpha}(n,j)=\sum_\alpha Y_{v\alpha}(n,j)$$
$$\sum_\alpha Z'_{0\alpha}(n,j)=\sum_\alpha Z_{v\alpha}(n,j)$$

The Ruhr of a ** type and color separation asks. The usual input video signal in it Since there is only a signal of red and three green and blue colors, by the Ruhr of the color separation It is necessary to separate the specific gravity or video signal of each primary color. Xtoalpha (n, j), Ytoalpha (n, j) and Ztoalpha (n, j) are all the tristimulus values of alpha color primary color in the pixel of the j-th piece of n drawings of a monitor. alpha in it is red and all the tristimulus values of alpha color virtual primary color [in / one in green and blue is shown and / in Xvalpha (n, j), Yvalpha (n, j), and Zvalpha (n, j) / the pixel of the j-th piece of n drawings]. alpha in it is one in tristimulus values, the sum of the tristimulus values of said formula adds the tristimulus values of all primary colors, and it is [Equation 14] about each above-mentioned formula, respectively.

$$a_\alpha(n,j)=\sum_\beta c^m_{\alpha\beta}(j)s^m_\beta(n,j)$$

When it puts into a ** type, aalpha (n, j) is called for and Smbeta (n, j) is the video signal of beta color primary color in the pixel of the j-th piece of n drawings of a monitor. When converting the red in it, and a green and blue input video signal, Smbeta (n, j) is a video signal. When beta expresses red, green, or blue and the video signal of three or more colors is converted, Smbeta (n, j) is a video signal corresponding to each primary color already separated by red and the green or blue input video signal. beta is the approach of being one of them and compensating the ununiformity of the display by change of the primary color of a color monitor according to claim 9 characterized by Cm**** (j) being a thing about the conversion coefficient in the pixel of the j-th piece of a monitor.

[Claim 14] The step which calculates a conversion coefficient is the approach of compensating the ununiformity of the display by change of the primary color of a color monitor according to claim 9 characterized by substituting for the formula of the conversion coefficient which obtained the chromaticity coordinate of each primary color of each pixel in a monitor, and the measured value of the maximum brightness at the step which looks for the relation between an input video signal and a light source modulating signal.

[Claim 15] The step which memorizes a conversion coefficient in the system which converts a video signal into a light source modulating signal, and step which accepts a video signal in a control unit Step which downloads the conversion coefficient memorized by memory to an arithmetic and logic unit Step calculated by the arithmetic and logic unit How to compensate the ununiformity of the display by change of the primary color of a color monitor according to claim 9 characterized by having the step which converts a video signal into a light source modulating signal.

[Claim 16] While the light source modulating signal acquired in the step which converts a video signal is used for the step which generates a light source driving signal and modulating the driving signal of primary color When it has relation with the nonlinear the brightness and the amount of modulations of a driving signal of the primary color in it, Before modulating a light source modulating signal to the driving signal of primary color, this nonlinear relation is corrected and a light source modulating signal is amended. The amount of modulations of a driving signal For example, it is the approach of compensating the ununiformity of the display by change of the primary color of a color monitor according to claim 9 which the magnitude of the starting current is expressed in the case of amplitude modulation, and is characterized by expressing the pulse width of the starting current in the case of pulse width modulation.

[Translation done.]

3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the approach of compensating the ununiformity of the display by change of the primary color of a color monitor.
[0002]
[Description of the Prior Art] A general color monitor has red and green and blue three primary colors. When the chromaticity coordinate of one primary color in each pixel combined with monitor display is not the same respectively, the color display of primary color will be an ununiformity. moreover, the new primary color of distribution of the chromaticity coordinate of primary color to a lot — choosing — the original three primary colors in each pixel — each — ****** — primary color can be made. However, since the new primary color as which only the one light source was chosen in practice cannot be displayed, this new primary color is called virtual primary color. In case it carries out, the original primary color is changed to virtual primary color ****. The chromaticity coordinate of virtual primary color is the same as that of each pixel, and it is because a color display will be homogeneity. Generally this approach is called a virtual primary color method, and can be applied to all the monitors that the ununiformity of color generates.
[0003] Usually, monitor display can consist of many pixels and one pixel in a color monitor can emit a light in three primary colors. However, the ununiformity of color will occur with such a display technique. For example, if color which is different to the area where screens differ is displayed and primary color is not displayed on homogeneity to display the primary color of the same brightness on the whole screen, a difference will arise in the color when displaying. This phenomenon is one of the main causes of degradation of the image quality of a light emitting diode monitor. Moreover, while each pixel of a matrix-type coloring light emitting diode monitor consists of light emitting diode of red and three blue and green colors, the coloring light emitting diode monitor of a scanning formula becomes one scanning screen from the light emitting diode of one or more linear matrices, and further, since there is a considerable difference in the different optics and the different electrical property of light emitting diode while these two kinds of monitors need to use a lot of light emitting diode, the light emitting diode monitor is not excellent in color homogeneity. For example, although a manufacture manufacturer chooses before shipping light emitting diode, the usually chosen blue or green light emitting diode has the variation of 10% or more of chromaticity coordinate and such variation cannot attain a uniform color display, variation can be stopped if the outstanding light emitting diode is chosen. However, as for the matrix type monitor of 800x600, at least 480,000 light emitting diodes need whenever [analysis] for one primary color. Therefore, when it has such quantity, it is very difficult to enforce the approach of said selection.
[0004]
[Objects of the Invention] This invention compensates the ununiformity of the display by change of the primary color of a color monitor by solving the above-mentioned technical problem and using a virtual primary color method.
[0005]
[Means for Solving the Problem] While this invention measures the chromaticity coordinate and the maximum brightness of primary color of each pixel in a monitor and the maximum brightness is brightness generated when not the brightness generated according to the light source of primary color but a fixed current or an electrical potential difference is built in case luminescence of primary color is modulated by pulse width, brightness is average brightness in a time slot. The virtual primary color of a lot is chosen from the measured value of all primary colors, and the tristimulus values of each virtual primary color occur from each pixel in a monitor. The property of the virtual primary color Since it can permute by the virtual primary color which had primary color chosen while being displayed by a chromaticity coordinate and the maximum brightness Since the color display of a monitor becomes homogeneity, and homogeneity is accepted in the color display in a monitor when the difference of the tristimulus values of primary color and virtual primary color is small while having virtual primary color with all the same pixels, The tristimulus values of primary color and the tristimulus values of virtual primary color in a pixel the same or in order to make it similar You may set up so that it may be similar, or it looks for the relation between an input video signal and a light source modulating signal and the tristimulus values of primary color and the tristimulus values of virtual primary color are in agreement. Furthermore, a conversion coefficient is calculated, an input video signal is changed into a light source modulating signal, and the approach of compensating the ununiformity of the display by change of the primary color of a color monitor characterized by generating the driving signal of the primary color in a monitor with a light source modulating signal is offered.
[0006]
[Embodiment of the Invention] Hereafter, the gestalt of suitable operation of this invention is explained to a detail with reference to an accompanying drawing.
[0007] While drawing 1 shows distribution of primary color in the CIE1931 (X, Y) chromaticity-coordinate system concerning this invention Are the coordinate Fig. showing the color field of the triangle of the example, drawing 2 is the coordinate Fig. showing the color field of 2 sets of virtual primary colors chosen based on drawing 1 , and drawing 3 converts an input video signal into a light source modulating signal. It is the block diagram of the system with which the ununiformity of color is compensated, and drawing 4 is the block diagram of the operation of the arithmetic and logic unit in drawing 3 . While drawing 5 shows distribution of four kinds of primary colors in the CIE1931 (X, Y) chromaticity-coordinate system concerning this invention It is the coordinate Fig. showing the color field of the square of the example, and drawing 6 is the coordinate Fig. showing the color field of four virtual primary colors of the lot chosen based on drawing 5 . Drawing 7 is the block diagram of the system which inputs red, green, and blue and converts a video signal into four kinds of light source modulating signals. Drawing 8 is the block diagram of the system which converts four kinds of video signals into four kinds of light source modulating signals, and drawing 9 is the block diagram of the operation of the arithmetic and logic unit in drawing 8 .
[0008] Here, the chromaticity coordinate system in CIE 1931 explains a virtual primary color method. Moreover, this approach can be used by other chromaticity coordinate systems.
[0009] As shown in drawing 1 , by the approach of compensating the ununiformity of the display by change of the primary color of the color monitor of this invention, red and green and blue chromaticity coordinate in three primary colors are in four way type ****** of R, G, and B, respectively, and a configuration like [like the field] is sufficient as them, and, generally they say such a field as a primary color area. Furthermore, the chromaticity coordinate of three triangular top-most vertices is good also

as a chrometicity coordinate of the primary color of a lot, the color field in a triangle is formed of the primary color of a lot, and the field of this triangle is called color field triangle. Moreover, while each pixel in a monitor has a color field triangle corresponding to it, the top-most vertices are located in which [in the primary color field corresponding to it] one point and such a color field triangle is called primary color field triangle, the coordinate of the top-most vertices is called virtual primary color field triangle.

[0010] As mentioned above, by choosing virtual primary color, a virtual primary color field triangle is located in a primary color field triangle, and the same virtual color field as each pixel in a monitor is displayed. Although the color field of the approach is small, since the color saturation ratio of light emitting diode is high, the virtual color field to choose is larger than a general color field, for example, a CRT monitor and a liquid crystal display monitor are the example. Moreover, as shown in drawing 2, while Rvi, Gvi, and Bvi show the red of the i-th set, and green and blue virtual primary color as other approaches of choosing virtual primary color, respectively (1<=i<=2), the virtual color field corresponding to virtual primary color is also shown. Moreover, as shown all over drawing, the color field of the first set is larger then the second set, and the greatest virtual color field is located between primary color fields from all top-most vertices. However, it is better to choose according to an operating condition, since the greatest color field is not the best selection. For example, virtual primary color is chosen and the primary color of CRT which is other monitor techniques, or LCD is simulated.

[0011] Moreover, when the light outputted from the light emitting diode in a monitor can control brightness by amplitude modulation or pulse width modulation, it uses amplitude modulation and the brightness and signal of output light use pulse width modulation proportionally, time amount is divided into the time slot of the same spacing, and the pulse width and the signal of output light are proportional within the one time slot. Moreover, when the width of face of a time slot is suitable, vision brightness is proportional to the brightness of an average of a time slot. Therefore, although the brightness of the pulse of a rectangular light is the same to all time slots, amplitude modulation can adjust the visual effect of a pulse, furthermore, when using a virtual primary color method for the system of pulse width modulation, while brightness can express the brightness of an average of one time slot and being able to express the brightness I with the formula of I=sxIm, the conditions of s are 0<=s<=1 — Im expresses the maximum brightness. Moreover, when using it for the system of amplitude modulation, while s is related to the reinforcement of the signal which starts light emitting diode, when using it for the system of pulse width modulation, s is related to the pulse width of a seizing signal, and the maximum brightness Im here is not the maximum brightness that light emitting diode generates but brightness generated according to a fixed actuation current.

[0012] the chromaticity coordinate of red and green and blue virtual primary color -- respectively (Xvr, Yvr) — and (Xvg, Yvg) (Xvb, Yvb) while being expressed, the maximum brightness of red and green and blue virtual primary color is expressed with Imvr, Imvg, and Imvb, respectively. When choosing these maximum brightness, while always making brightness required for primary color into a forward value, it is necessary to fulfill the conditions of a white balance proportionally between them.

[0013] for example, the brightness generated from the red in the pixel of the j-th piece of n drawings, and green and blue virtual primary color — respectively — Ivr (n, j), Ivg (n, j), and Ivb (n, j) — (— n, j= 1, and 2 and 3 ...) — it is — while -- [0014]

[Equation 15]

$$I_{v\alpha}(n,j) = s_{\alpha}(n, j) I^{m}_{v\alpha}, \quad (\alpha = r, g, b) \qquad (1)$$

[0015] It can come out and express. sr(s) (n, j), sg(s) (n, j), and sb(s) (n, j) in it are red and a green and blue video signal, respectively. Furthermore, [0016]

[Equation 16]

$$0 \leq s_{\alpha}(n, j) \leq 1, \qquad (\alpha = r, g, b) \qquad (2)$$

Usually expressing with RGB the input video signal boiled and set, the relation between the tristimulus values of CIE and a chrometicity coordinate is [0017].

[Equation 17]

$$X^{m}_{v\alpha} = h(x_{v\alpha}/y_{v\alpha}) I^{m}_{v\alpha}$$

$$Y^{m}_{v\alpha} = h I^{m}_{v\alpha}, \qquad (\alpha = r, g, b) \qquad (3a)$$

$$Z^{m}_{v\alpha} = h[(1 - x_{v\alpha} - y_{v\alpha})/y_{v\alpha}] I^{m}_{v\alpha}$$

[0018] And [0019]

[Equation 18]

$$X_{v\alpha}(n, j) = h(x_{v\alpha}/y_{v\alpha}) I_{v\alpha}(n, j),$$

$$Y_{v\alpha}(n, j) = h I_{v\alpha}(n, j), \qquad (\alpha = r, g, b) \qquad (3b)$$

$$Z_{v\alpha}(n, j) = h[(1 - x_{v\alpha} - y_{v\alpha})/y_{v\alpha}] I_{v\alpha}(n, j),$$

[0020] It comes out. While Xmvalpha, Ymvalpha, and Zmvalpha in it are the three maximum color stimulus values corresponding to virtual primary color, respectively, Xvalpha (n, j), Yvalpha (n, j), and Zvalpha (n, j) are the tristimulus values of the virtual primary color in the pixel of the j-th piece of n drawings, respectively, and h is a constant for converting brightness into Y stimulus value.

[0021] In order to attain the increment in a white balance or brightness, the light emitting diode of the one or more same colors is required in a pixel. for example, the chromaticity coordinate of the red of the i-th piece in the pixel of the j-th piece, and green and blue light emitting diode — respectively (xori (j) —) yori (j) — and (xogi (j), yogi (j)) (xobi (j), yobi (j)) — it is — while — The red of the i-th piece in the pixel of the j-th piece of n drawings, and the maximum brightness of green and blue light emitting diode, respectively Imori (j), Imogi (j) it is , and Imobi (j) and the red of the i-th piece in the pixel of the j-th piece of n drawings and all the brightness of green and blue light emitting diode are Iort (n, j), Iogt(n, j),, and Iobt (n, j), respectively. Therefore, they are [0022].

[Equation 19]

$$I'_{o\alpha}(n,j)=a_{\alpha}(n,j)\sum_{i=1}I^{m}_{o\alpha}(j) \quad (\alpha=r,\ g,\ b) \tag{4}$$

[0023] It can express with a ** type. While Nr(s), Ng(s), and Nb(s) in it are the red in a pixel, and the quantity of green and blue light emitting diode, respectively, ar (n, j), ag (n, j). and ab (n, j) are the input signals of red and green and blue light emitting diode, respectively, and the range of the signal is [0024].
[Equation 20]

$$0 \le a_{\alpha}(n,j) \le 1 \quad , \quad (\alpha=r,\ g,\ b) \quad . \tag{5}$$

[0025] It can express with a ** type. Since the amplitude modulation or Pulse Density Modulation of light emitting diode is performed by using those input signals, the signal is called a light source modulating signal. I hear that the pulse width of the starting current of Pulse Density Modulation is not proportional to the brightness, either, and there are notes here while the size of the brightness of light emitting diode and the starting current of amplitude modulation is not proportional. Therefore, as shown below, it is necessary to change the formula.
[0026]
[Equation 21]

$$X^{m}_{o\alpha}(j)=h\sum_{i=1}^{N_{\alpha}}[x_{o\alpha i}(j)/y_{o\alpha i}(j)]I^{m}_{o\alpha}(j),$$
$$Y^{m}_{o\alpha}(j)=h\sum_{i=1}^{N_{\alpha}}I^{m}_{o\alpha}(j), \quad (\alpha=r,g,b) \tag{6a}$$
$$Z^{m}_{o\alpha}(j)=h\sum_{i=1}^{N_{\alpha}}\{[1-x_{o\alpha i}(j)-y_{o\alpha i}(j)]/y_{o\alpha i}(j)\}I^{m}_{o\alpha}(j),$$

[0027] And [0028]
[Equation 22]

$$X'_{o\alpha}(n,j)=h\sum_{i=1}^{N_{\alpha}}[x_{o\alpha i}(j)/y_{o\alpha i}(j)]I_{o\alpha}(n,j),$$
$$Y'_{o\alpha}(n,j)=h\sum_{i=1}^{N_{\alpha}}I_{o\alpha}(n,j), \quad (\alpha=r,g,b) \tag{6b}$$
$$Z'_{o\alpha}(n,j)=h\sum_{i=1}^{N_{\alpha}}\{[1-x_{o\alpha i}(j)-y_{o\alpha i}(j)]/y_{o\alpha i}(j)\}I_{o\alpha}(n,j),$$

[0029] Xmoalpha in it (j), Ymoalpha (j), and Zmoalpha (j) are the tristimulus values of the primary color corresponding to the pixel of the j-th piece, and Xtoalpha (n, j), Ytoalpha (n, j), and Ztoalpha (n, j) show the tristimulus values of the primary color corresponding to the pixel of the j-th piece of n drawings.
[0030] If said definition shows the parameter of the light emitting diode in each pixel of a monitor, by using the approach shown below, virtual primary color can be chosen and the luminescence brightness of primary color can be made into a forward value.
[0031] The maximum of the tristimulus values in red virtual primary color is [0032].
[Equation 23]

$$X^{m}_{vr}=Min\{X^{m}_{or}(j)\},$$
$$Y^{m}_{vr}=Max\{Y^{m}_{or}(j)\}, \tag{7a}$$
$$Z^{m}_{vr}=Max\{Z^{m}_{or}(j)\},$$

[0033] It is chosen by the ** type. Xmor in it (j), and Ymor (j) -- reaching -- while Zmor (j) is the maximum of the tristimulus values of the red primary color in the pixel of the j-th piece of a monitor, Min [V (j)] is the minimum value V to all j, and Max [V (j)] is the maximum V to all j. Furthermore, the maximum of the tristimulus values in green virtual primary color is [0034].
[Equation 24]

$$X^{m}_{vg}=Max\{X^{m}_{og}(j)\},$$
$$Y^{m}_{vg}=Min\{Y^{m}_{og}(j)\}, \tag{7b}$$
$$Z^{m}_{vg}=Max\{Z^{m}_{og}(j)\},$$

[0035] It is chosen by the ** type and Xmog (j), Ymog (j), and Zmog (j) in it are the maximum of the tristimulus values of the green primary color in the pixel of the j-th piece of a monitor. The maximum of the tristimulus values in blue virtual primary color

is [0036].
[Equation 25]

$$X_{vb}^{m} = Max\{X_{ob}^{m}(j)\},$$
$$Y_{vb}^{m} = Max\{Y_{ob}^{m}(j)\},\qquad (7c)$$
$$Z_{vb}^{m} = Min\{Z_{ob}^{m}(j)\},$$

[0037] It is chosen by the ** type and Xmob in it (j), Ymob (j), and Zmob (j) are the maximums of the tristimulus values of the green primary color in the pixel of the j-th piece of a monitor.
[0038] It mentioned above — as — the maximum brightness and chromaticity coordinate of each virtual primary color — respectively — a formula (7a) thru/or (7c) selection -- things are made. In that case, naturally a white balance needs to adjust the ratio between the maximum brightness in each virtual primary color. Moreover, why this approach is effective is explained below.
[0039] Usually, X stimulus value of red light emitting diode, Y stimulus value of green light emitting diode, and Z stimulus value of blue light emitting diode are larger than the stimulus value of two sorts of others in red light emitting diode, green light emitting diode, and blue light emitting diode respectively. Here, red virtual primary color is explained as an example. Since red X stimulus value is the minimum value it can generate from the red light emitting diode in each pixel, but since Y and Z stimulus value are maximums, it cannot generate from red light emitting diode. However, the insufficient part is easily suppliable from the green in the same pixel, and blue light emitting diode respectively. Therefore, it can be made to correspond to the conditions of a formula (5). Moreover, what is necessary is to be used when a formula (7a) thru/or (7c) light emitting diode have been arranged at each pixel in a monitor, and just to change a few based on a formula (7a) thru/or (7c) this approach, when determining virtual primary color before light emitting diode is installed.
[0040] Next, the relation between a light source modulating signal and an input video signal is explained. The conditions in that case are making equal the tristimulus values of the light generated from all the light emitting diodes in a pixel, and the tristimulus values of all virtual primary colors. The relation can be decided by the following formula.
[0041]
[Equation 26]

$$\sum_{\alpha=r,g,b} X_{0\alpha}^{i}(n,j) = \sum_{\alpha=r,g,b} X_{v\alpha}(n,j),$$
$$\sum_{\alpha=r,g,b} Y_{0\alpha}^{i}(n,j) = \sum_{\alpha=r,g,b} Y_{v\alpha}(n,j),\qquad (8)$$
$$\sum_{\alpha=r,g,b} Z_{0\alpha}^{i}(n,j) = \sum_{\alpha=r,g,b} Z_{v\alpha}(n,j),$$

[0042] A light source modulating signal is searched for by this formula (8).
[0043]
[Equation 27]

$$a_r(n,j) = c_{rr}(j)s_r(n,j) + c_{rg}(j)s_g(n,j) + c_{rb}(j)s_b(n,j),$$
$$a_g(n,j) = c_{gr}(j)s_r(n,j) + c_{gg}(j)s_g(n,j) + c_{gb}(j)s_b(n,j),\qquad (9)$$
$$a_b(n,j) = c_{br}(j)s_r(n,j) + c_{bg}(j)s_g(n,j) + c_{bb}(j)s_b(n,j).$$

[0044] Although light emitting diode emits light continuously to each pixel on the screen of the light emitting diode monitor of a scanning formula, as for notes here, the light source modulating signal of the same Fig. frame does not necessarily perform a light source modulation to coincidence. Moreover, alpha, beta=r, and (g, b) are [0045], when it is a conversion coefficient and expresses with a formula further. [c***** (j) in a formula (9), and]
[Equation 28]

$$c_{\alpha\beta}(j)=[d_{\alpha x}(j)X^{m}_{v\beta}+d_{\alpha y}(j)Y^{m}_{v\beta}+d_{\alpha z}(j)Z^{m}_{v\beta}]/\Delta(j),\qquad (10)$$
$$d_{rx}(j)=Y^{m}_{0g}(j)Z^{m}_{0b}(j)-Y^{m}_{0b}(j)Z^{m}_{0g}(j),$$
$$d_{ry}(j)=X^{m}_{0b}(j)Z^{m}_{0g}(j)-X^{m}_{0g}(j)Z^{m}_{0b}(j),$$
$$d_{rz}(j)=X^{m}_{0g}(j)Y^{m}_{0b}(j)-X^{m}_{0b}(j)Y^{m}_{0g}(j),$$
$$d_{gx}(j)=Y^{m}_{0b}(j)Z^{m}_{0r}(j)-Y^{m}_{0r}(j)Z^{m}_{0b}(j),$$
$$d_{gy}(j)=X^{m}_{0r}(j)Z^{m}_{0b}(j)-X^{m}_{0b}(j)Z^{m}_{0r}(j),$$
$$d_{gz}(j)=X^{m}_{0b}(j)Y^{m}_{0r}(j)-X^{m}_{0r}(j)Y^{m}_{0b}(j),$$
$$d_{bx}(j)=Y^{m}_{0r}(j)Z^{m}_{0g}(j)-Y^{m}_{0g}(j)Z^{m}_{0r}(j),$$
$$d_{by}(j)=X^{m}_{0g}(j)Z^{m}_{0r}(j)-X^{m}_{0r}(j)Z^{m}_{0g}(j),$$
$$d_{bz}(j)=X^{m}_{0r}(j)Y^{m}_{0g}(j)-X^{m}_{0g}(j)Y^{m}_{0r}(j),$$

$$\Delta(j)=\begin{vmatrix} X^{m}_{or}(j) & X^{m}_{og}(j) & X^{m}_{ob}(j) \\ Y^{m}_{or}(j) & Y^{m}_{og}(j) & Y^{m}_{ob}(j) \\ Z^{m}_{or}(j) & Z^{m}_{og}(j) & Z^{m}_{ob}(j) \end{vmatrix}$$

[0046] ** — it becomes like. Therefore, if the chromaticity coordinate and brightness of each light emitting diode in a monitor are not surveyed and a conversion coefficient is known although the multiplier in a formula (10) cannot be obtained when using a virtual primary color method, an import video signal is convertible into a light source modulating signal by using software or hardware.

[0047] As shown in drawing 3, the conversion coefficient (c**** (j)) of each pixel in a monitor is computed by the formula (10), and is memorized in memory. Furthermore, while a control unit receives the input video signals sr (n, j), sg (n, j), and sb (n, j), a corresponding conversion coefficient is downloaded all over three arithmetic and logic units (ALU), and these three arithmetic and logic units convert a signal by the parallel mode operation of a formula (9). Moreover, as shown in drawing 4, it is the output of these three arithmetic and logic units, i.e., a light source modulating signal.

[0048] Therefore, when using three or more sorts of primary colors for a monitor, while being able to increase the color reproduction range, the color expression of the ununiformity in this kind of monitor can also be compensated by the virtual primary color method. For example, a matrix-type light emitting diode monitor is that example, and this monitor has yellowish green in addition to red, green, and blue. Moreover, as shown in drawing 5, the chromaticity coordinate of these red, yellowish green, and green and blue primary color was distributed over four way type within the limits of R, YG, G, and B, respectively, and those top-most vertices have appeared in the four way type which is the color field of primary color within the limits. Such a four way type is called a color reproduction range four way type. Moreover, as shown all over drawing, the color reproduction range four way type of the selected virtual primary color is generated in an original color reproduction range four way type. While choosing the maximum brightness of four virtual primary colors so that the brightness of primary color required in order to generate virtual primary color may always become a forward value as shown in drawing 6, a white balance needs to adjust the ratio between them.

[0049] Furthermore, while inputting a video signal and usually acquiring the video signal of four primary colors of correspondence by the Ruhr of color separation only by red and three green and blue sorts in the case of a 4 primary-color monitor The red and yellowish green which correspond, respectively, and the green and blue light source modulating signals ar (n, j), ay (n, j), ag (n, j), and ab (n, j) can be acquired by using this Ruhr and formula (8). Therefore, [0050]

[Equation 29]

$$a_r(n,j)=c'_{rr}(j)s_r(n,j)+c'_{rg}(j)s_g(n,j)+c'_{rb}(j)s_b(n,j),$$
$$a_y(n,j)=c'_{yr}(j)s_r(n,j)+c'_{yg}(j)s_g(n,j)+c'_{yb}(j)s_b(n,j),$$
$$a_g(n,j)=c'_{gr}(j)s_r(n,j)+c'_{gg}(j)s_g(n,j)+c'_{gb}(j)s_b(n,j),\qquad (11)$$
$$a_b(n,j)=c'_{br}(j)s_r(n,j)+c'_{bg}(j)s_g(n,j)+c'_{bb}(j)s_b(n,j),$$

[0051] Being able to express with a ** type, alpha=r, y and g, beta=r, and (g, b) are conversion coefficients. [c'****(j) in it, and]

[0052] According to the formula (11), as shown in drawing 7, the system block Fig. shown in an operating principle and drawing 3 is similar, and the actuation of the arithmetic and logic unit in drawing 7 of it is also the same as that of drawing 3. Moreover, the output of these four arithmetic and logic units is a light source modulating signal.

[0053] As other compensation approaches for a 4 primary-color monitor, there is a method of obtaining four corresponding red

and yellowish green, green and blue video signal s"r (n, j), s"y (n, j), s"g (n, j), and s"b (n, j), respectively, and these video signals are converted into a light source modulating signal by the Ruhr of color separation. It has the relation indicated below to be the approach of obtaining a formula (9) and an approach similar to it.

[0054]

[Equation 30]

$$a_r(n,j)=c'_{rr}{}'(j)s''_r(n,j)+c'_{ry}{}'(j)s''_y(n,j)+c'_{rg}{}'(j)s''_g(n,j)+c'_{rb}{}'(j)s''_b(n,j),$$
$$a_y(n,j)=c'_{yr}{}'(j)s''_r(n,j)+c'_{yy}{}'(j)s''_y(n,j)+c'_{yg}{}'(j)s''_g(n,j)+c'_{yb}{}'(j)s''_b(n,j),$$
$$a_g(n,j)=c'_{gr}{}'(j)s''_r(n,j)+c'_{gy}{}'(j)s''_y(n,j)+c'_{gg}{}'(j)s''_g(n,j)+c'_{gb}{}'(j)s''_b(n,j), \quad (12)$$
$$a_b(n,j)=c'_{br}{}'(j)s''_r(n,j)+c'_{by}{}'(j)s''_y(n,j)+c'_{bg}{}'(j)s''_g(n,j)+c'_{bb}{}'(j)s''_b(n,j),$$

[0055] It is alpha=r, y and g, b;beta=r, (y, g, b), and ***********, and I hear that it is not necessarily one and the selection approach of a conversion coefficient has notes here. [c'****' in it (j).] According to the formula (12), as shown in drawing 8 , while the system block Fig. shown in that operating principle and drawing 3 is similar, drawing 9 shows the operation of the arithmetic and logic unit in drawing 8 , and the output of these four arithmetic and logic units is a light source modulating signal.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The coordinate Fig. showing the color field of the triangle of the example while distribution of primary color is shown in the CIE1931 (X, Y) chromaticity-coordinate system concerning this invention

[Drawing 2] The coordinate Fig. showing the color field of 2 sets of virtual primary colors chosen based on drawing 1

[Drawing 3] The block diagram of the system with which an input video signal is converted into a light source modulating signal, and the ununiformity of color is compensated

[Drawing 4] The block of the operation of the arithmetic and logic unit in drawing 3

[Drawing 5] The coordinate Fig. showing the color field of the square of the example while distribution of four kinds of primary colors is shown in the CIE1931 (X, Y) chromaticity-coordinate system concerning this invention

[Drawing 6] The coordinate Fig. showing the color field of four virtual primary colors of the lot chosen based on drawing 5

[Drawing 7] The block diagram of the system which inputs red, green, and blue and converts a video signal into four kinds of light source modulating signals

[Drawing 8] The block diagram of the system which converts four kinds of video signals into four kinds of light source modulating signals

[Drawing 9] The block diagram of the operation of the arithmetic and logic unit in drawing 8

[Translation done.]

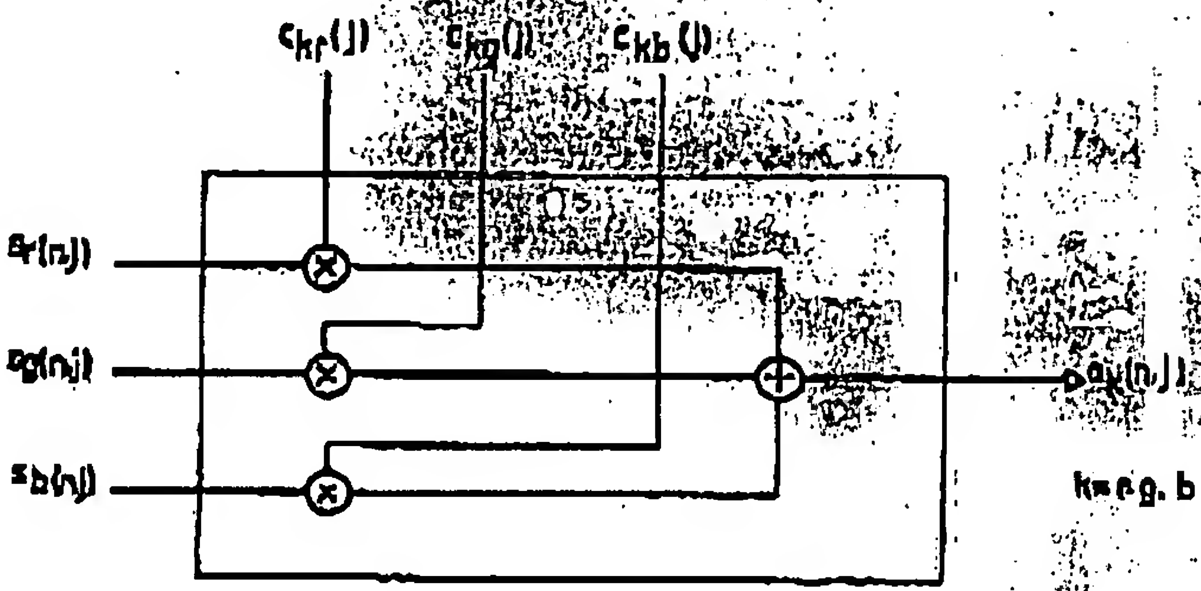
* NOTICES *

JPO and INPIT are not responsible for any damages caused by the use of this translation.

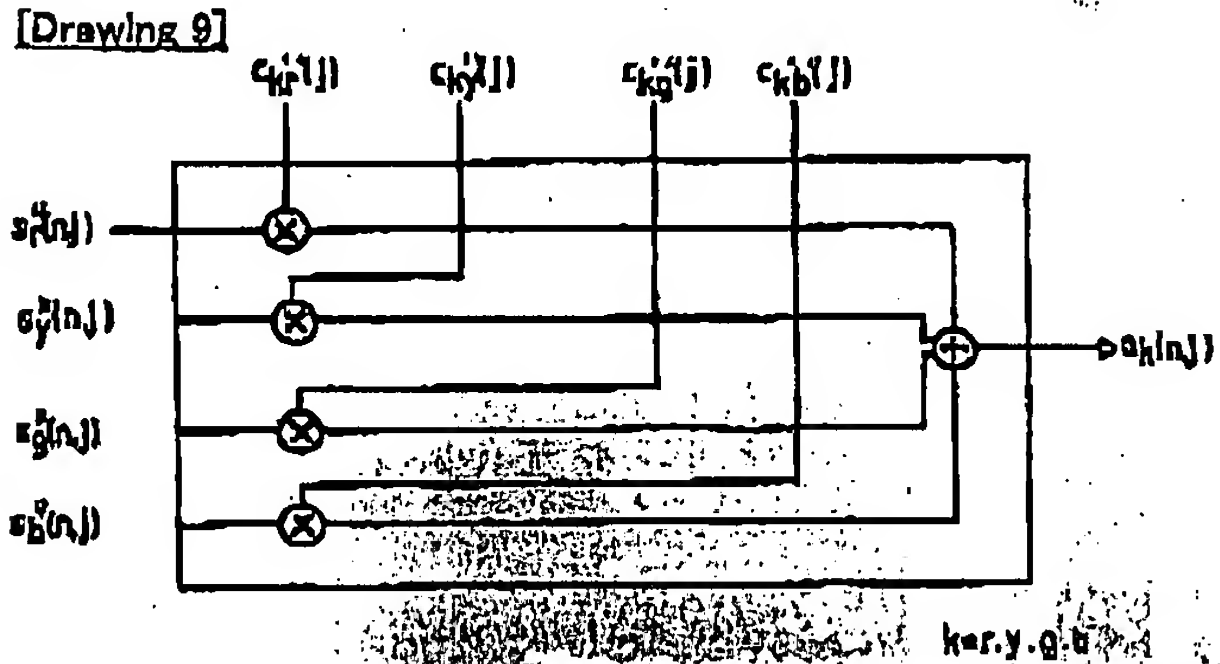
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

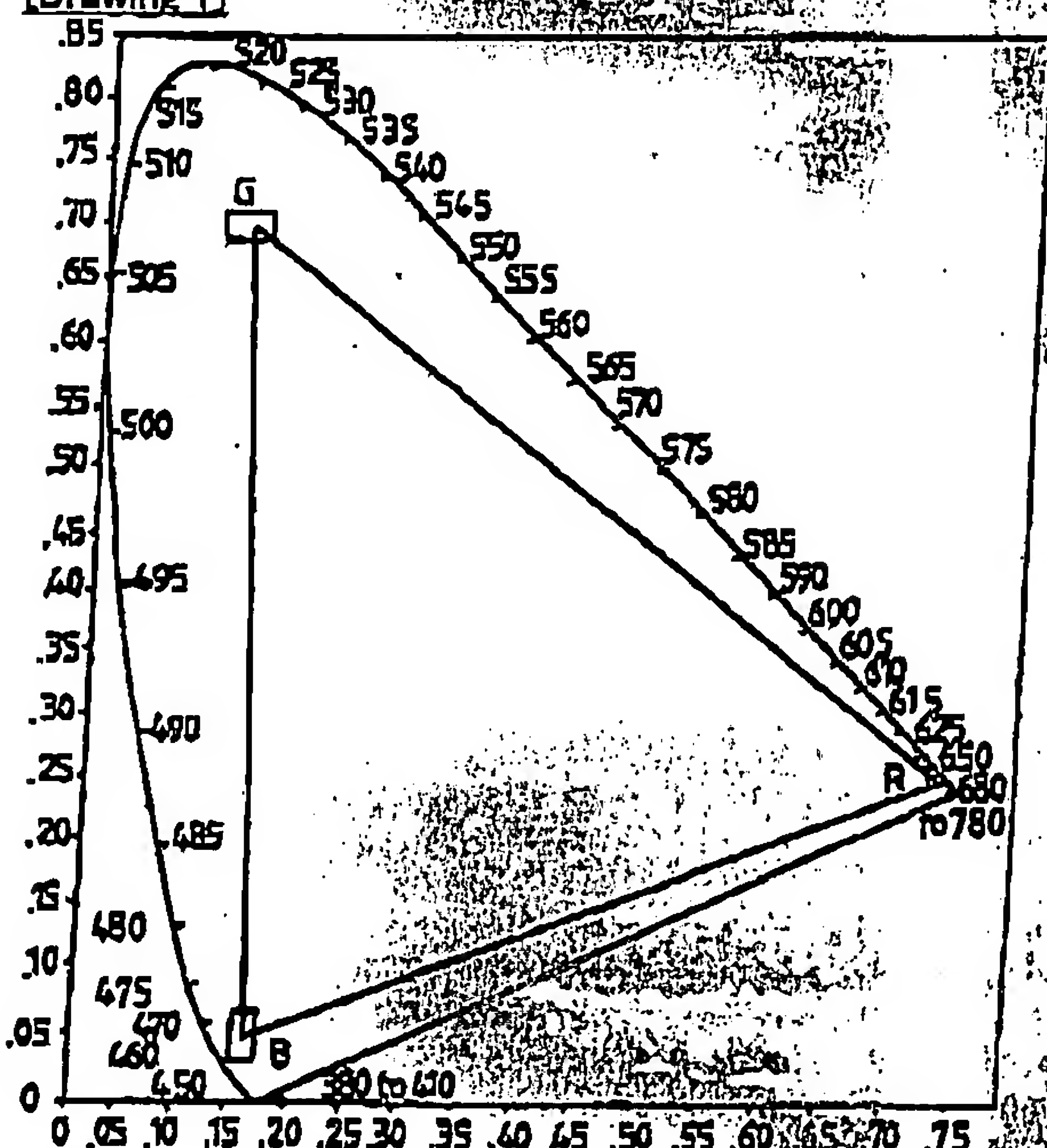
[Drawing 4]



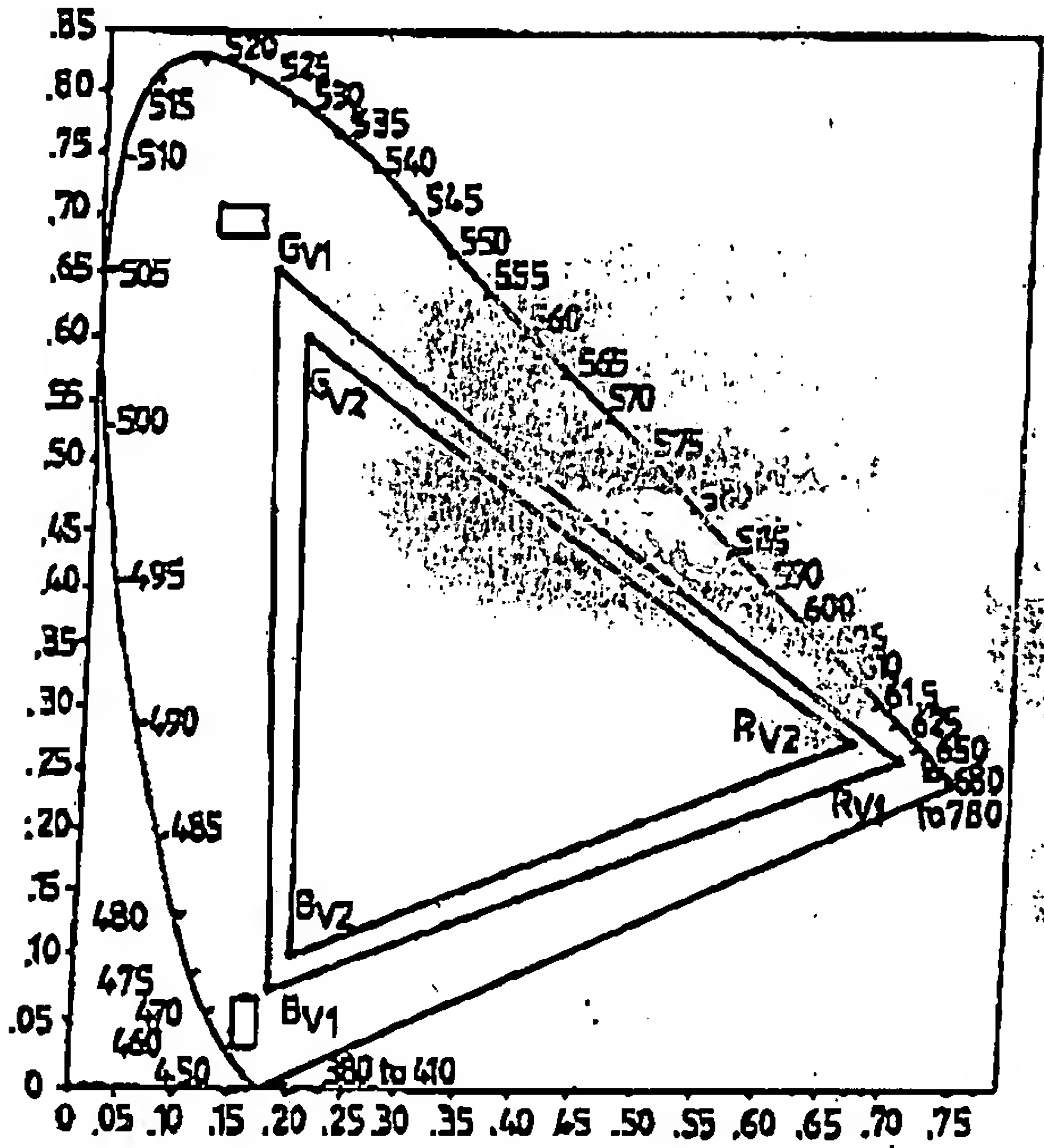
[Drawing 9]



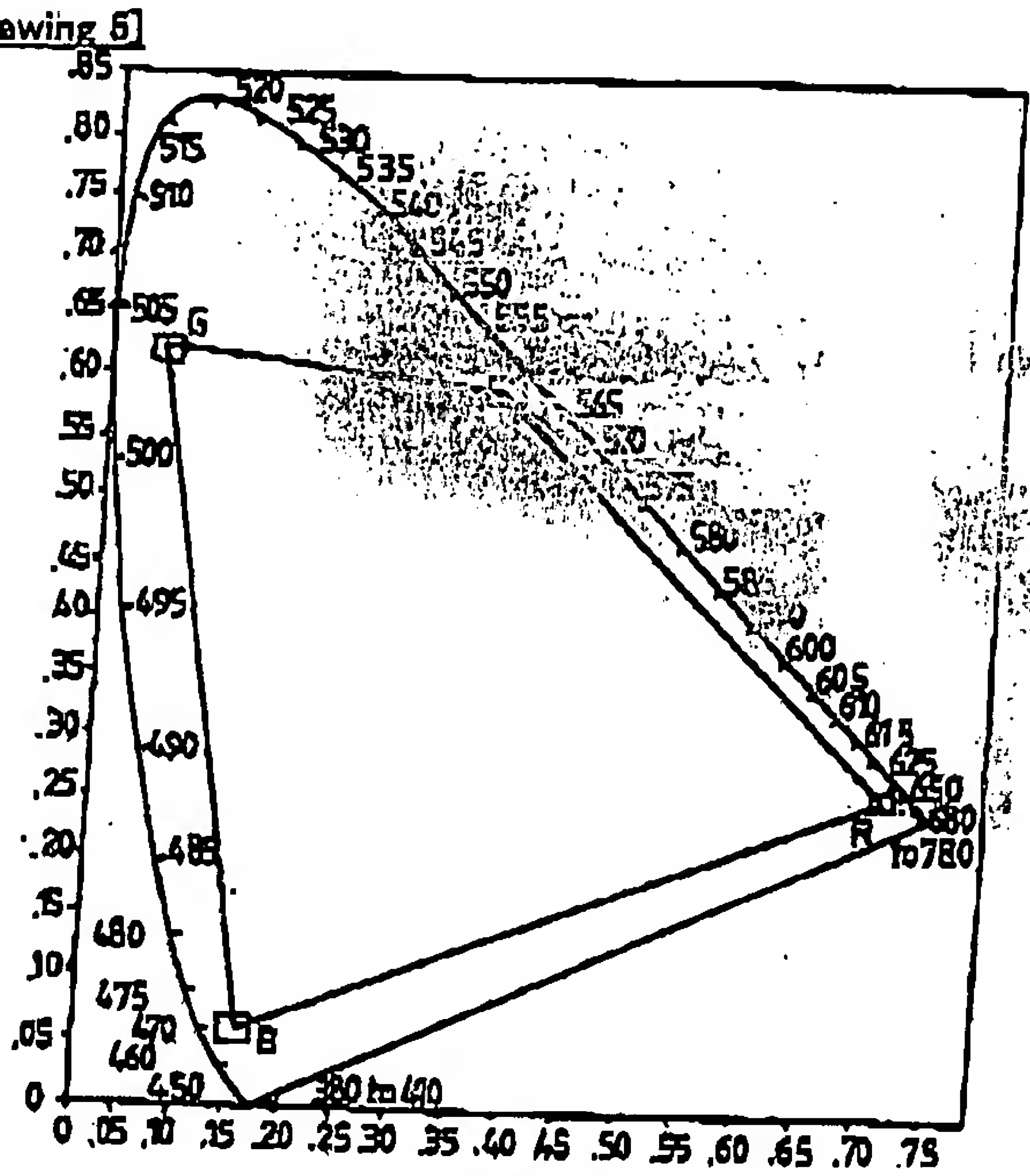
[Drawing 1]



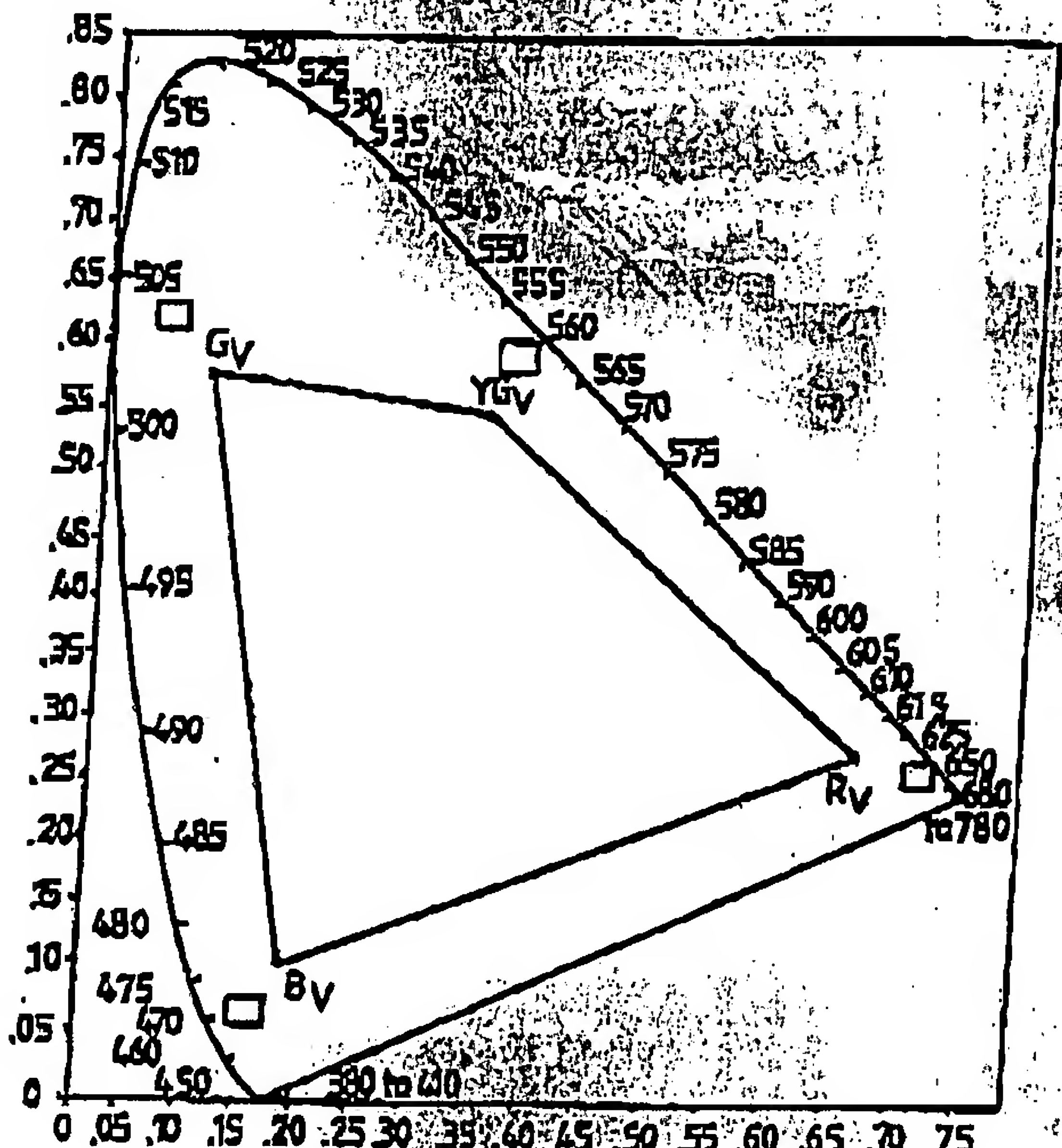
[Drawing 2]



[Drawing 5]



[Drawing 6]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505
500
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470
460
450
380 to 410
GV
YGV
RV
BV
.85
.80
.75
.70
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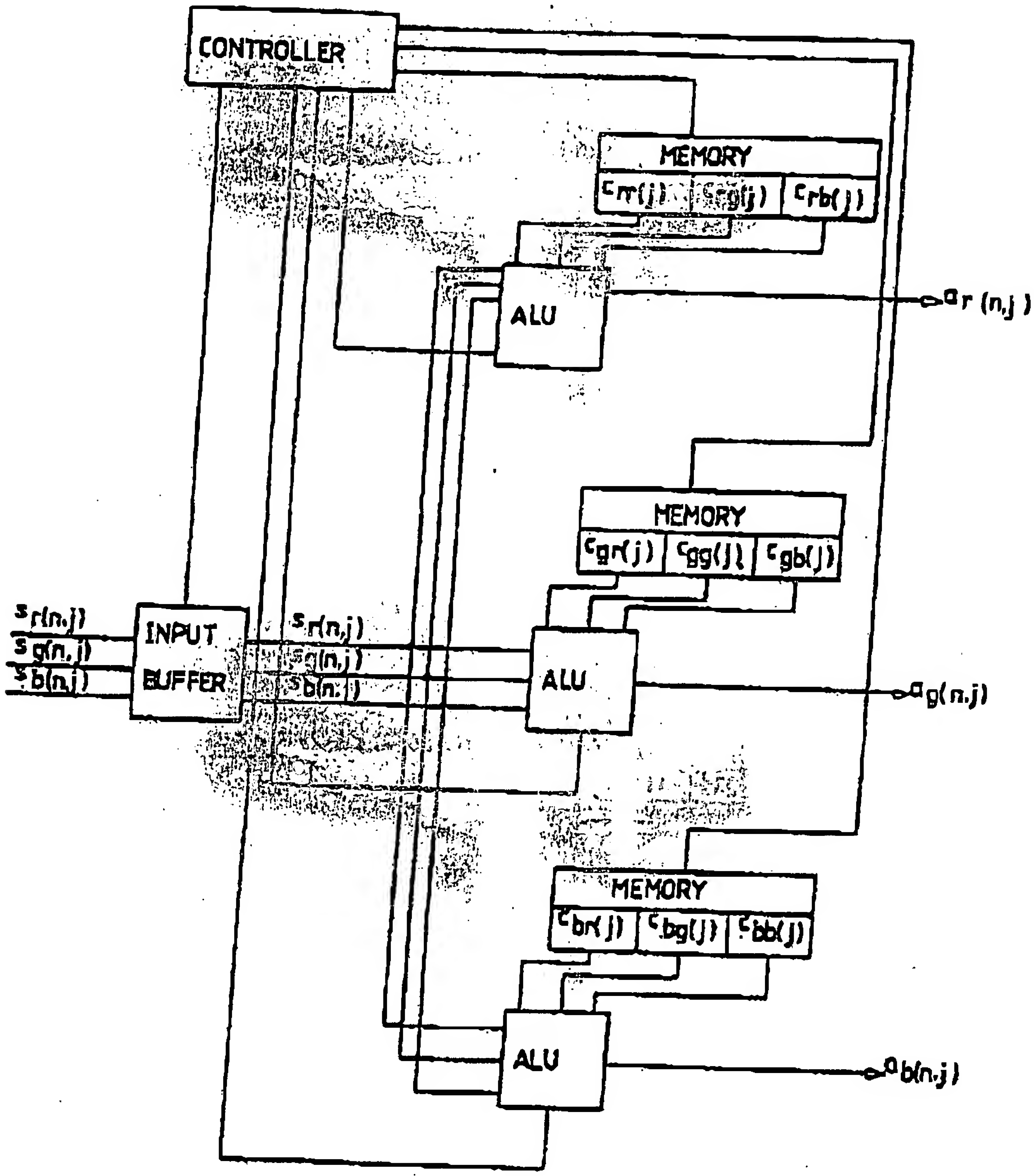
.75

[Drawing 3]


CONTROLLER
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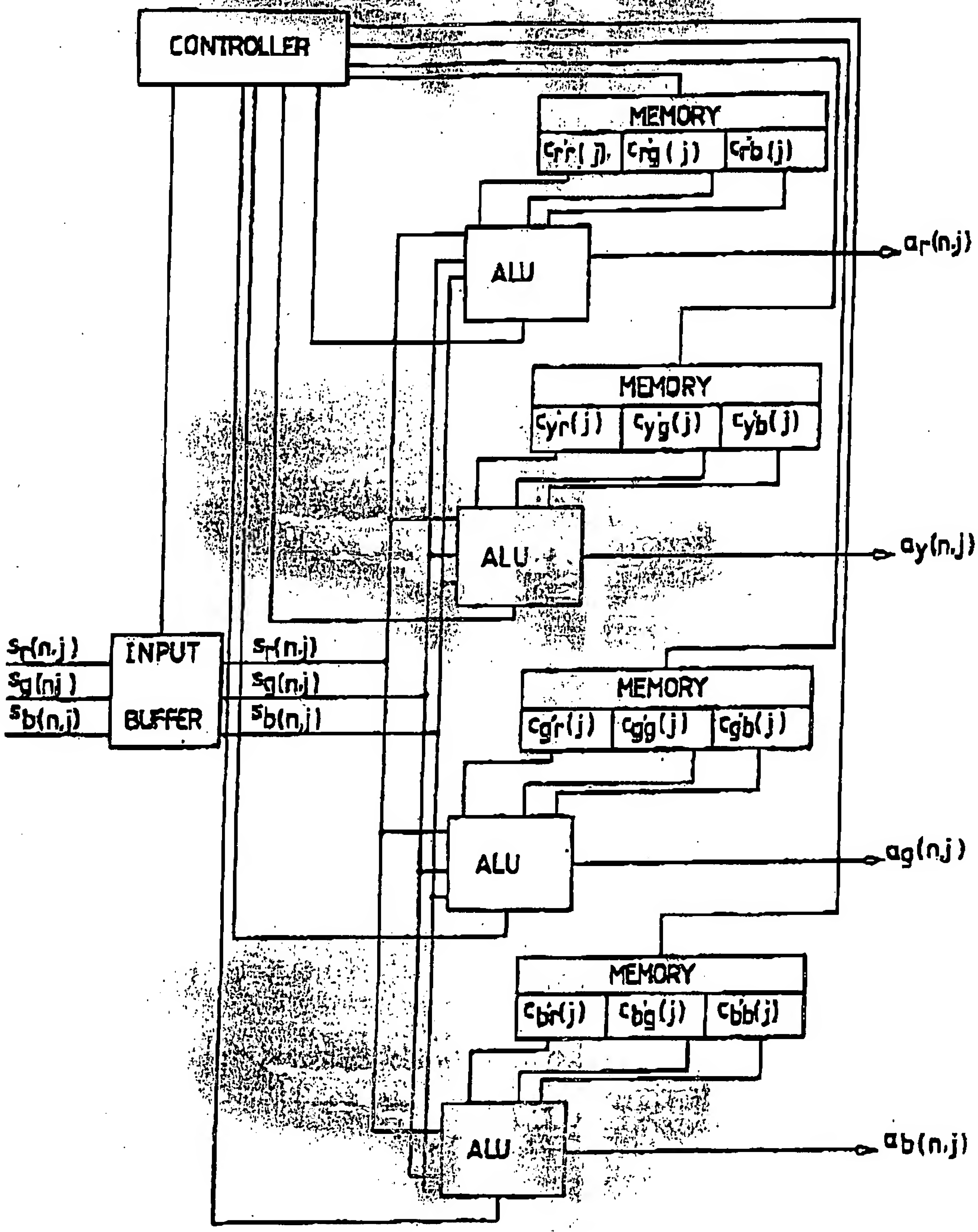
crg(j)
crb(j)
ALU
ar(n,j)
MEMORY
cgr(j)
cgg(j)
cgb(j)
sr(n,j)
sg(n,j)
sb(n,j)
INPUT
BUFFER
sr(n,j)
sg(n,j)
sb(n,j)
ALU
ag(n,j)
MEMORY
cbr(j)
cbg(j)
cbb(j)
ALU
ab(n,j)

[Drawing 7]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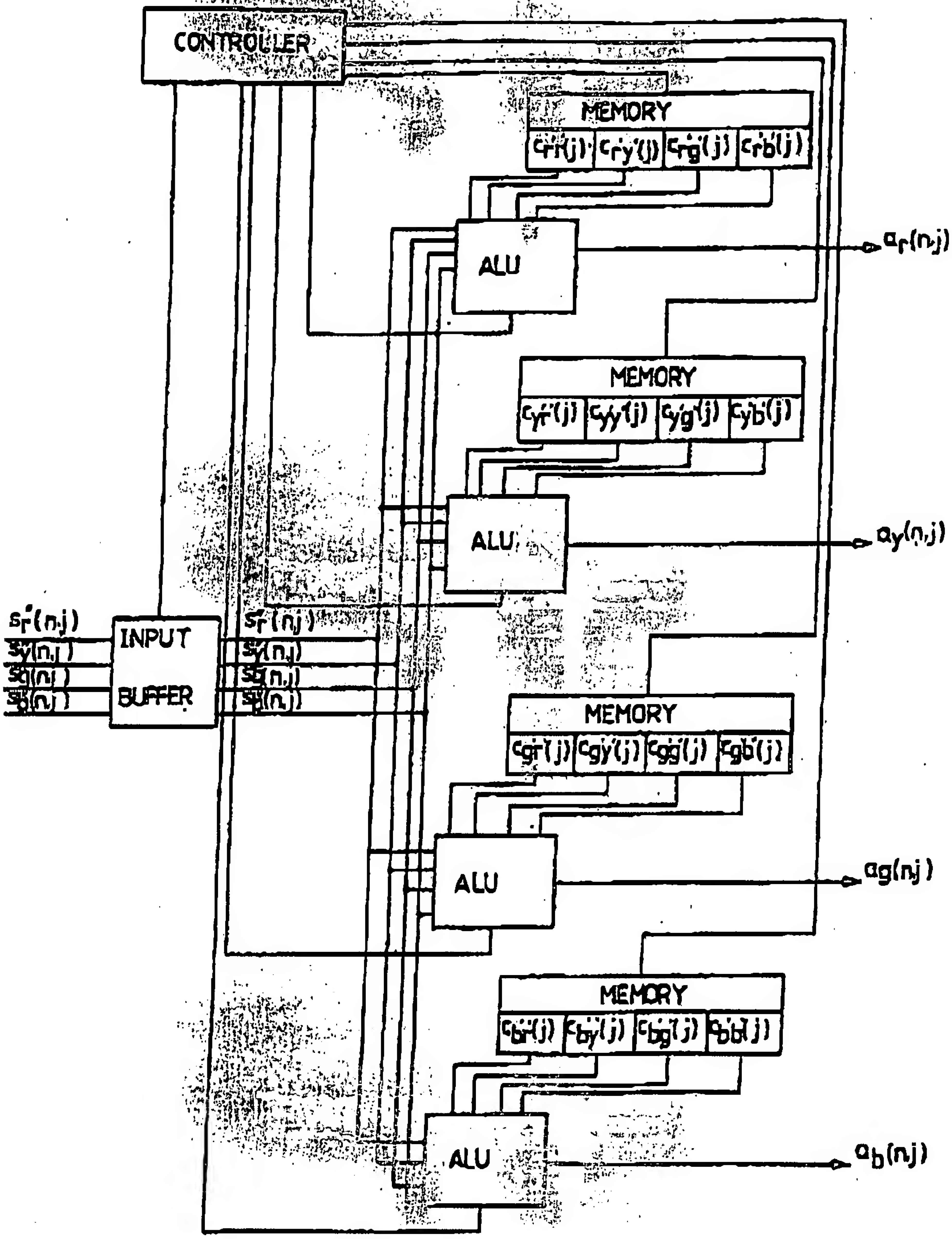
c'rb(j)
ALU
ar(n,j)
MEMORY
c'yr(j)
c'yg(j)
c'yb(j)
ALU
ay(n,j)
sr(n,j)
sg(n,j)
sb(n,j)
INPUT BUFFER
sr(n,j)
sg(n,j)
sb(n,j)
MEMORY
c'gr(j)
c'gg(j)
c'gb(j)
ALU
ag(n,j)
MEMORY
c'br(j)
c'bg(j)
c'bb(j)
ALU
ab(n,j)

[Drawing 8]



[Translation done.]